WISE IoT

Orchestrating a brighter world NEC

22. VDE/ITG Fachtagung **Mobilkommunikation**

IoT Platforms for Smart Cities

9th May, 2017
Martin Bauer
NEC Laboratories Europe

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IoT and Smart Cities

Vision

Imagine a Digital Skin on our Planet

A real INTERNET of Things

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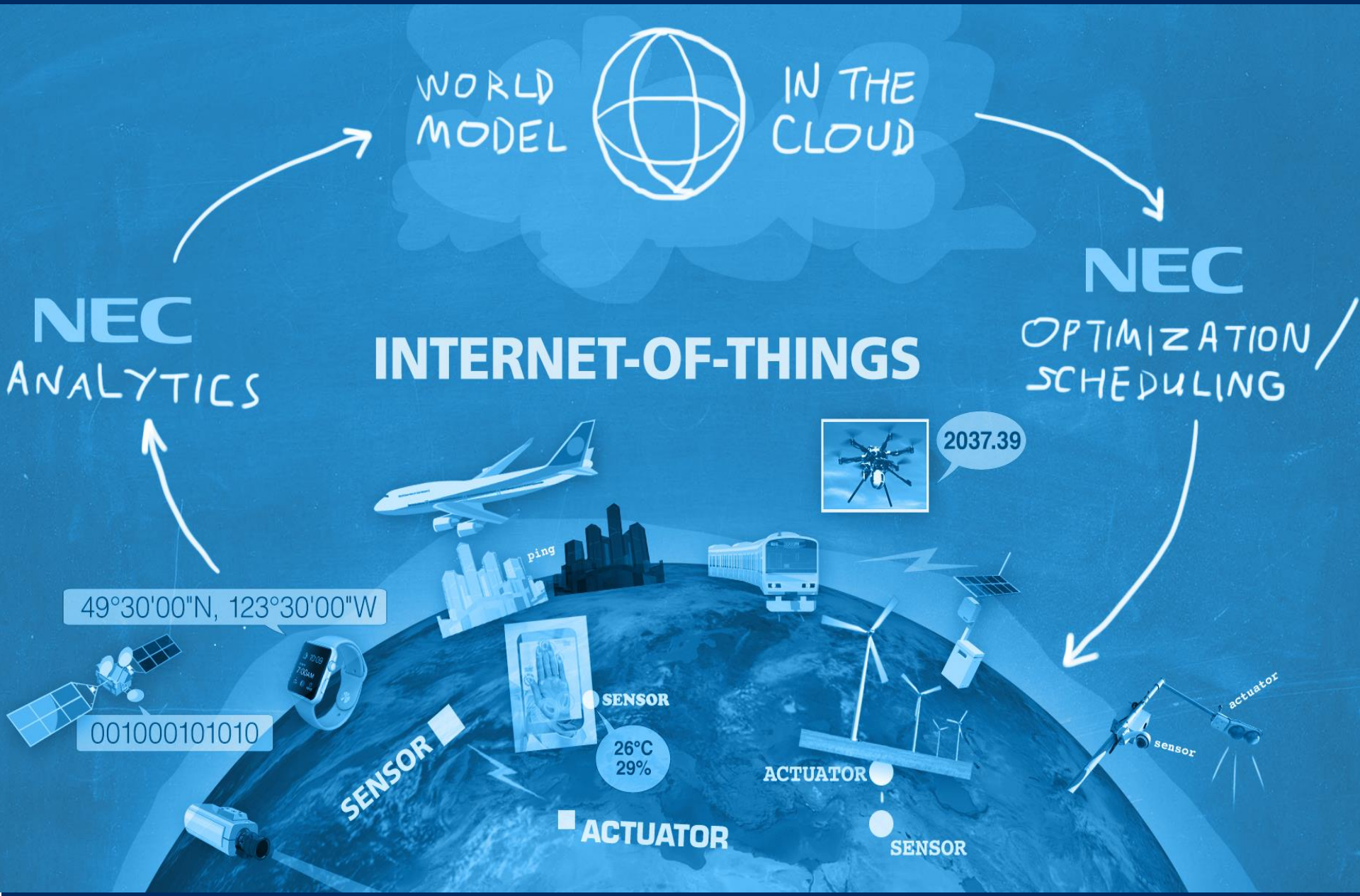
Internet of Things



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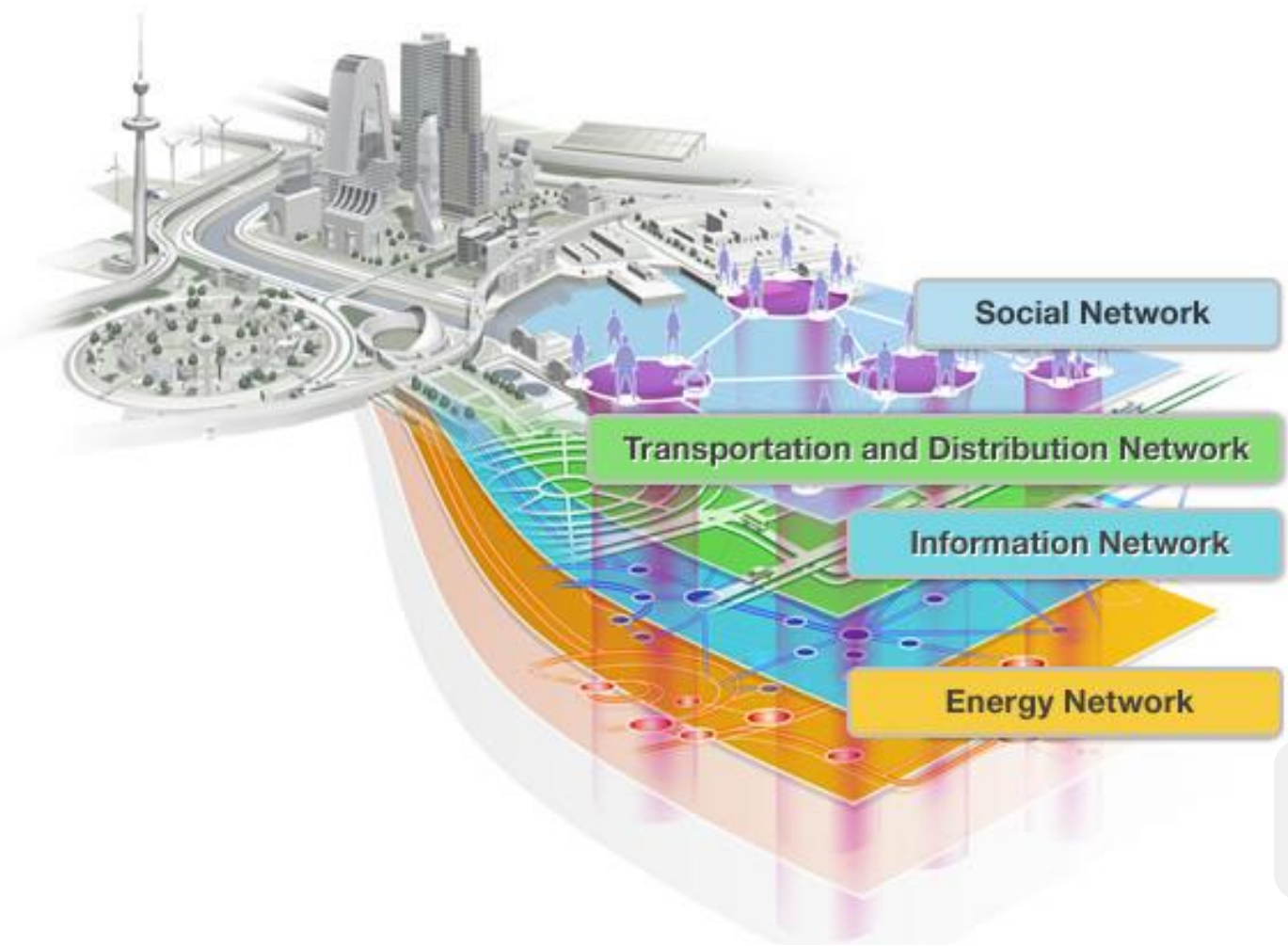
Smart City



Data platform is the brain

networks are its nerves

sensors are its skin

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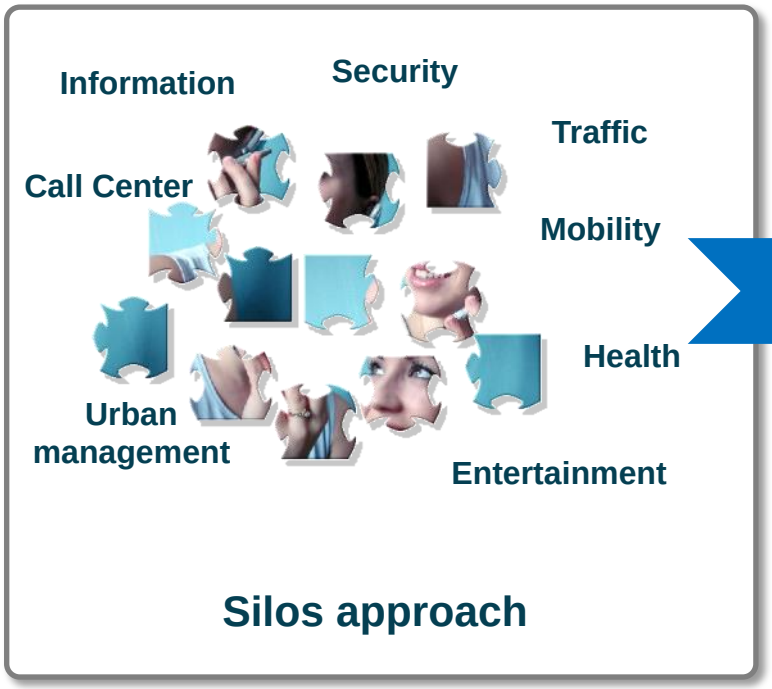
Smart City Platform holistic approach

Internet-of-Things is breaking down information barriers ...
->...the IoT platform should break the barriers between silos



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Example: Adapt Content to Environment

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Example: Measure the Health of a City

a Fitness Tracker for Smart Cities

FIWARE
OPEN APIs FOR OPEN MINDS
enabled product

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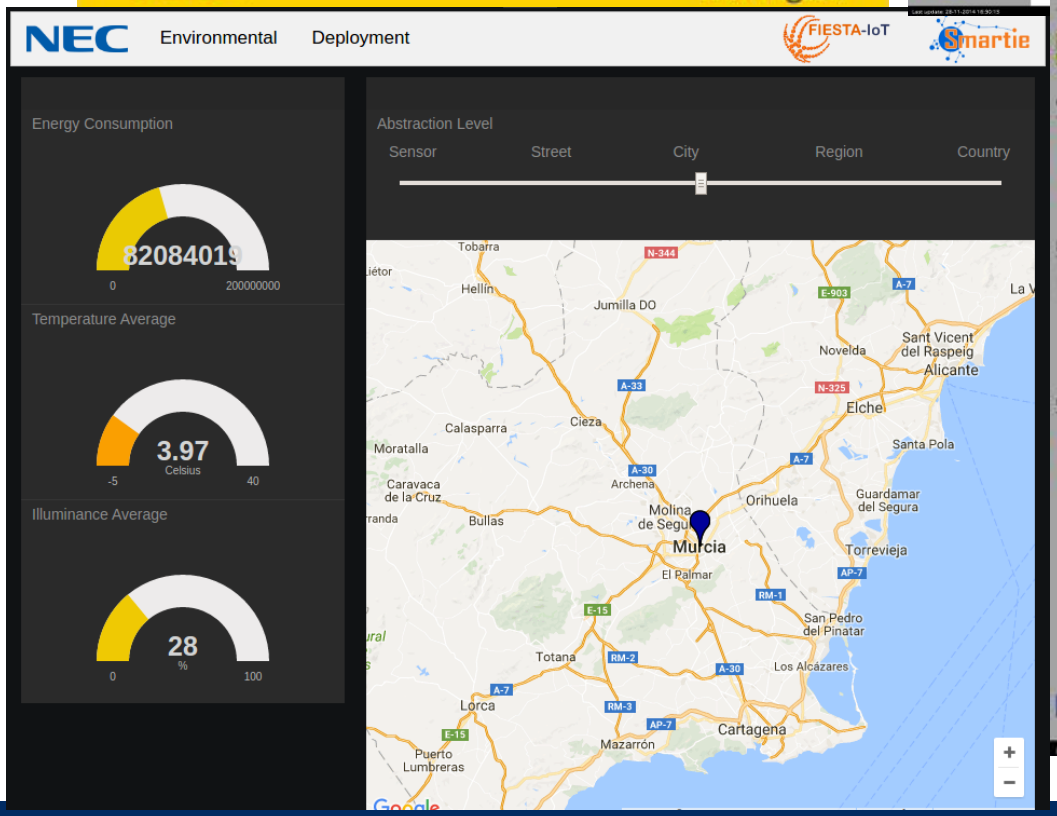
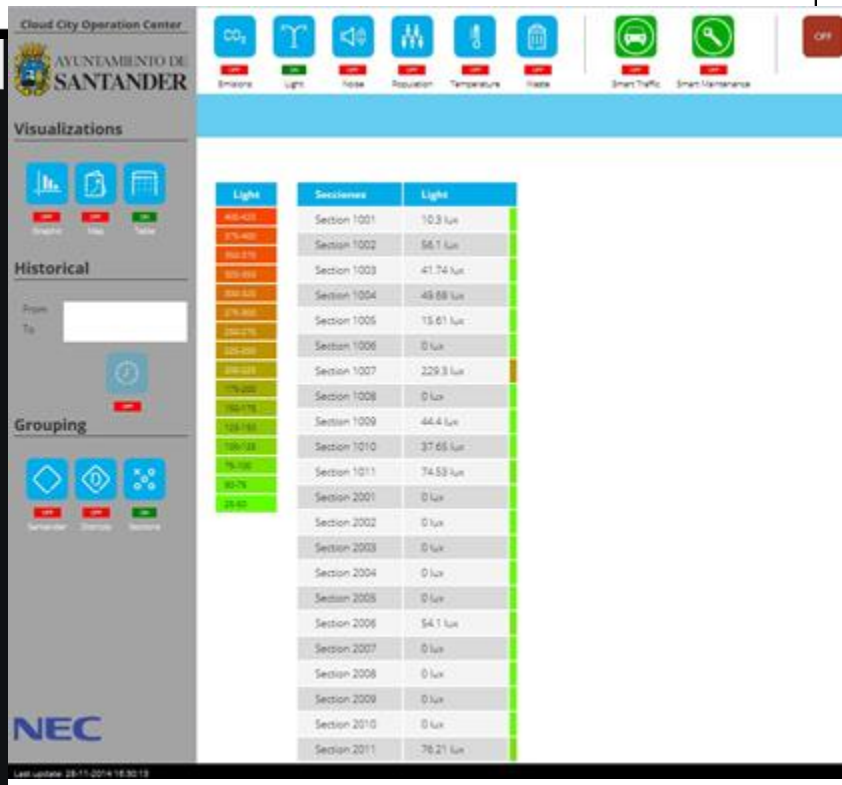
Example: Enabling Data-driven Business - Visualization





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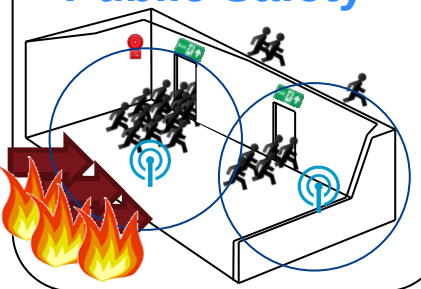
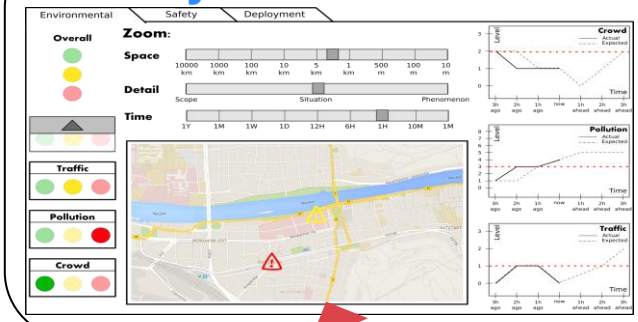
Example: Cross-Agency Smart City Services

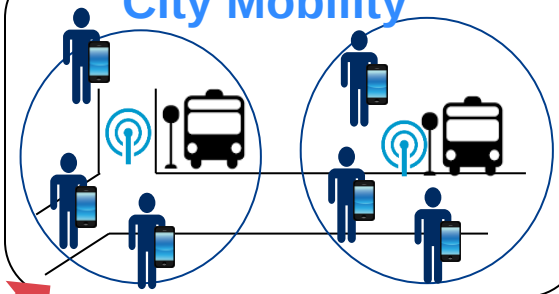
Public Safety



City Performance



City Mobility



Hospital

Transport agency

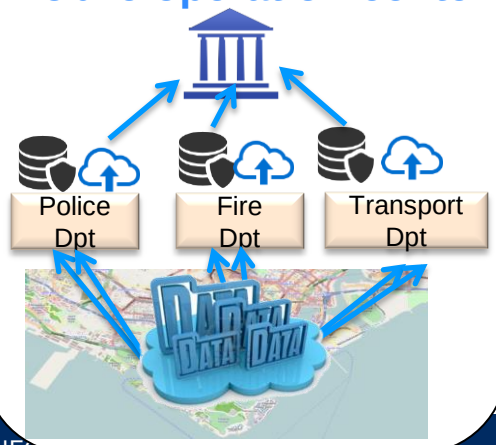
Environment Agency

Utility agency

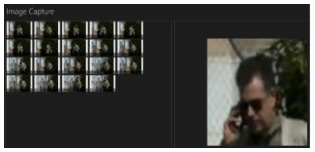
Police

Fire station

Mobile operation center



Surveillance



CityMagnifier: KPI of a City

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Wise-IoT Scenarios – Smart Parking

- User can view parking lot status and free parking space using application
- Reduces the time it takes to park the car by showing the location of the vacant parking space to the user
- Monitor the overall usage status of the parking lot

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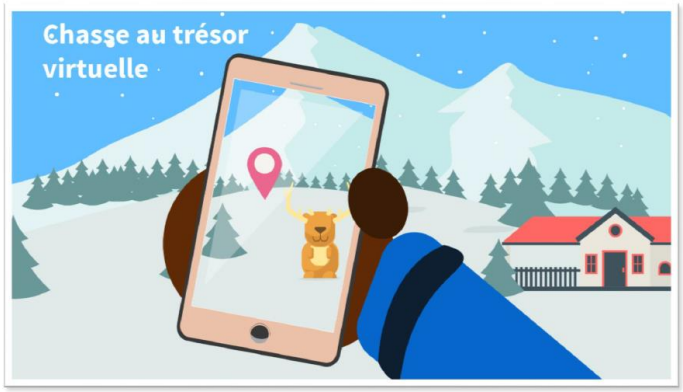
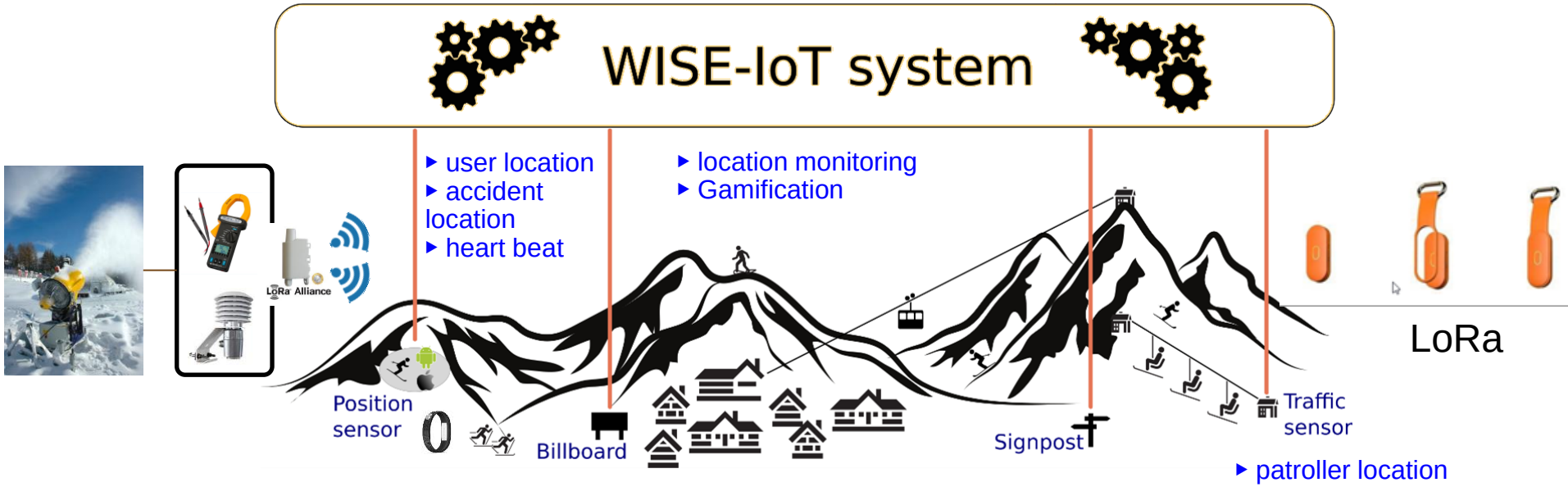
Wise-IoT Scenarios – Smart Skiing

Status for Station Manager



Virtual Treasure Hunt

Family Achievement View



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How can the sketched vision become reality?

- Connect to and make best use of **heterogeneous IoT device** and **communication technologies**
- Deal with **large scale** and **dynamically changing** set of devices
- Integrate devices into a **common IoT platform** to enable the **re-use** of devices as **information sources** and **actuators** by IoT applications **across domains**
- Provide a **suitable abstraction level** on which applications and services can **interact with the IoT platform,** i.e. specify the information they need or the aspect they want to change
- Support **analytics** that **create knowledge** on which basis **operations** can be **optimized**.

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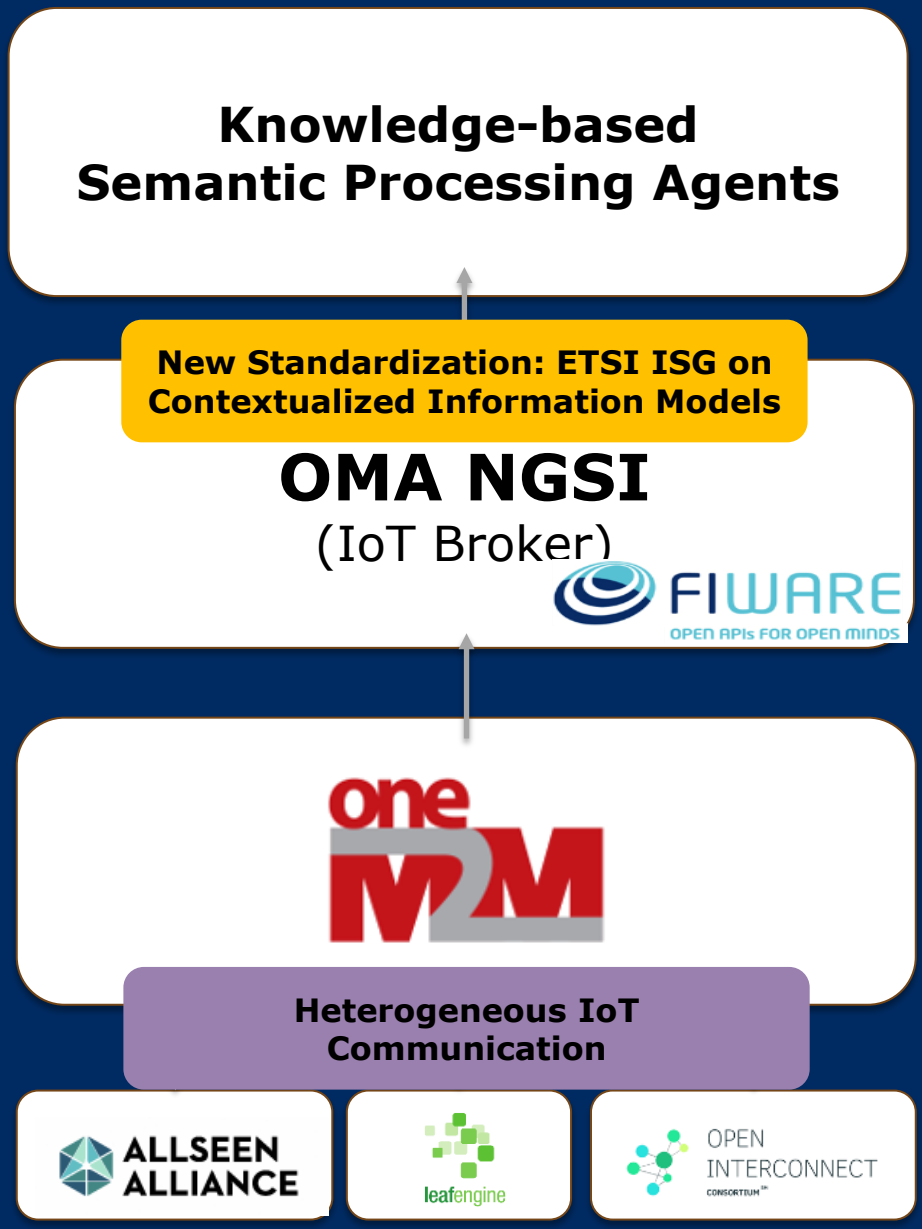
IoT and Smart Cities

IoT Stack and Standards

Emerging IoT Stack



Analytics and Knowledge
- Across many systems
- Semantic Representation
- Semantic Mediation

IoT Abstraction and Aggregation
- Contextualized Information
- Content-based Queries
- Pub / Sub

IoT Homogenization and Integration
- Black Box Content
- REST-based Access

IoT Devices and Deployment
- SDK
- OS Integration
- IoT Hardware

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oneM2M

IoT Homogenization and Integration

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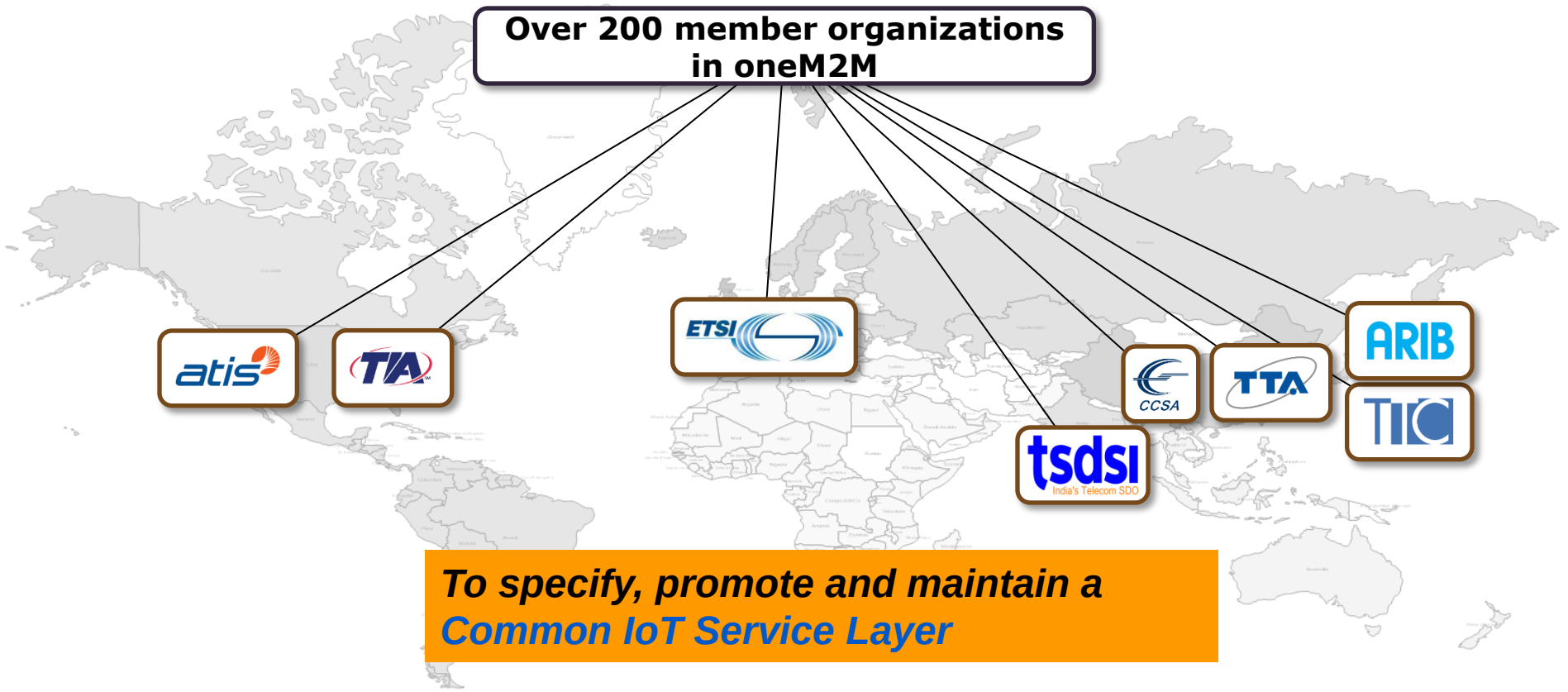
oneM2M Partnership Project



To specify, promote and maintain a Common IoT Service Layer

CEN CENELEC · broadband forum · oma Open Mobile Alliance · New Generation M2M Consortium · GlobalPlatform

www.oneM2M.org

All documents are publically available

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200+ members organizations

Some of the 200+ active members of oneM2M

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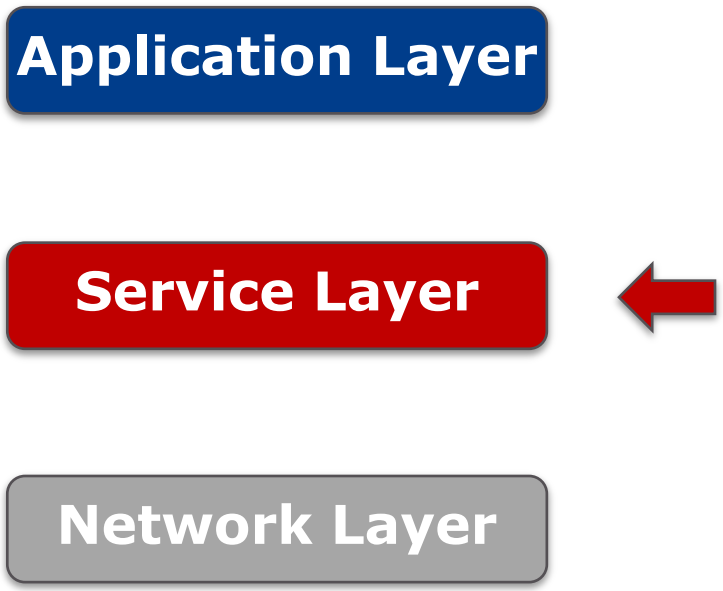
What is oneM2M?



- It is a software/middleware layer
- It sits between applications and underlying communication networking HW/SW
- It **exposes common set of functions** to applications via **REST API**
- It is integrated into devices gateways & servers
- It hides complexity of NW usage from apps
- It controls when communication happens
- It stores and shares data
- It supports access control

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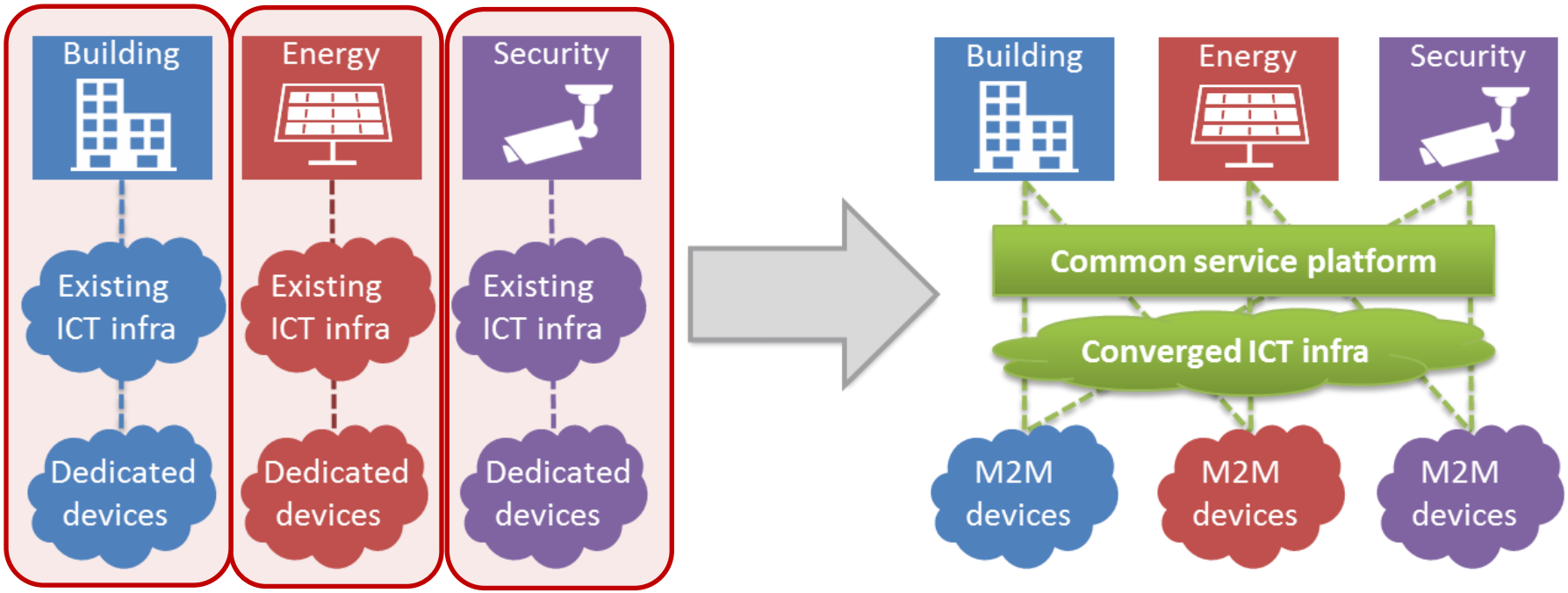
oneM2M Goal: IoT cross-domain interoperability



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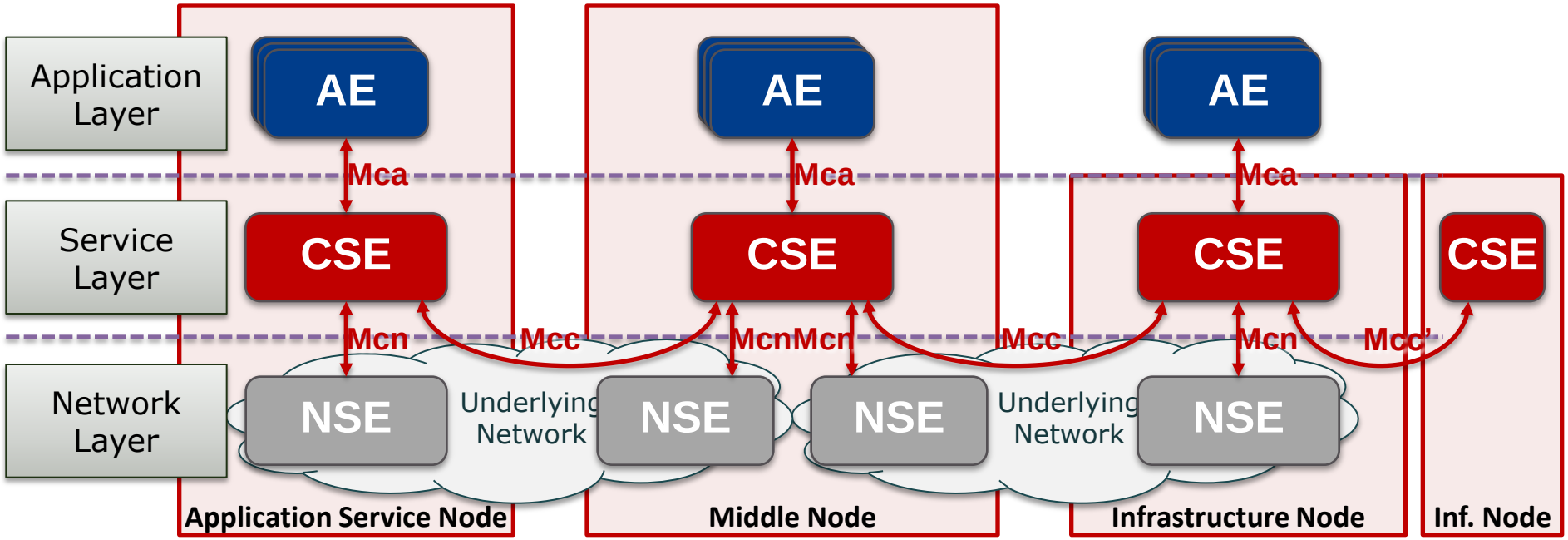
Architecture

Reference Point	One or more interfaces - Mca, Mcn, Mcc and Mcc' (between 2 service providers)
Common Services Entity	Provides the set of "service functions" that are common to the M2M environments
Application Entity	Provides application logic for the end-to-end M2M solutions
Network Services Entity	Provides services to the CSEs besides the pure data transport
Node	Logical equivalent of a physical (or possibly virtualized, especially on the server side) device



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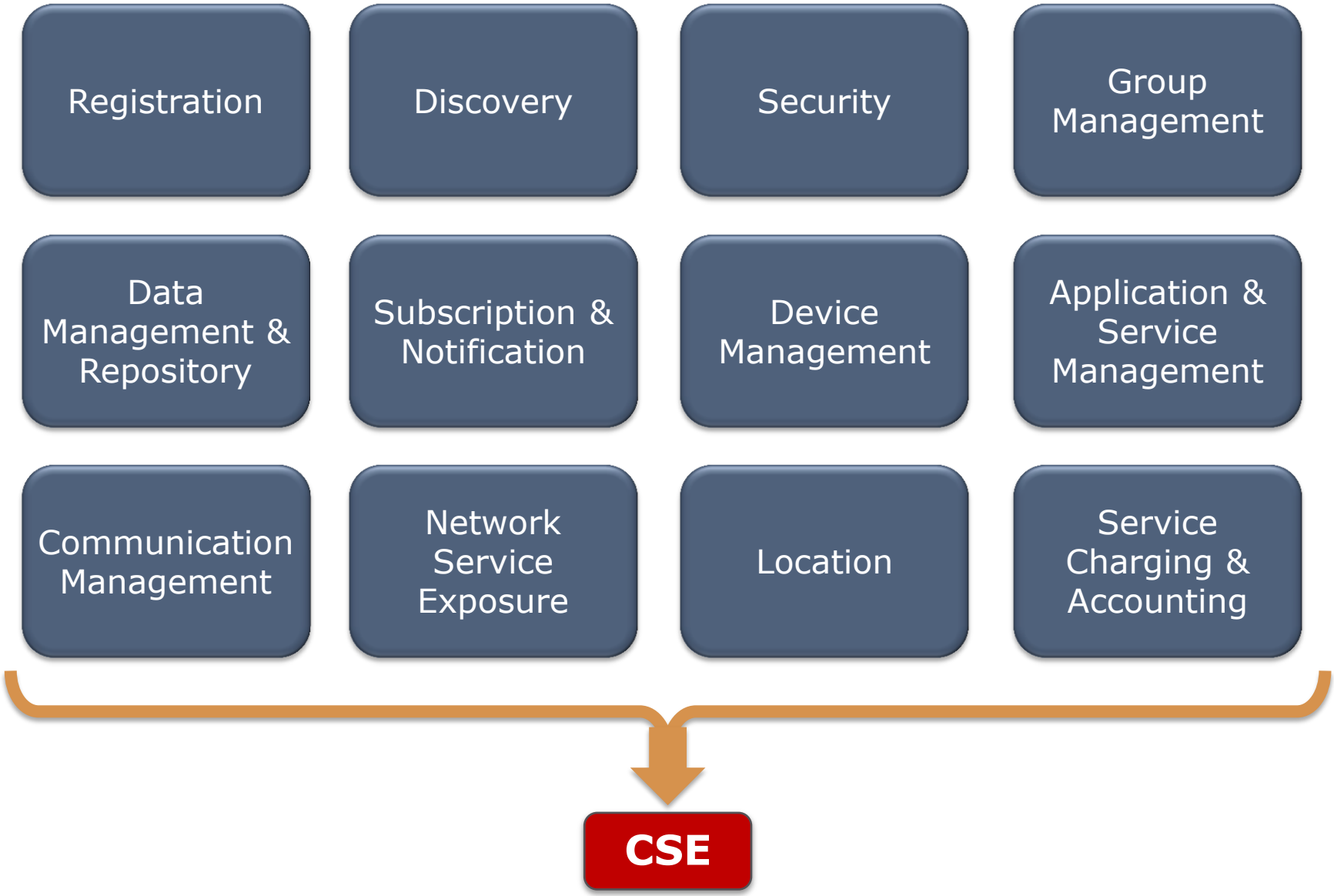
Common Service Functions



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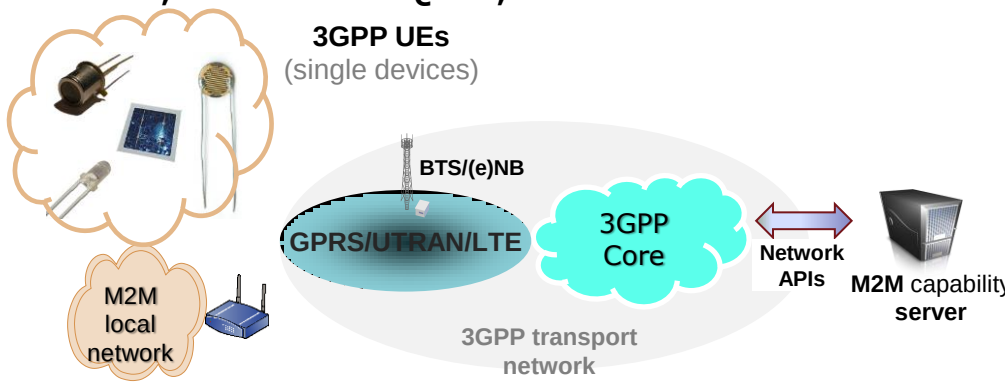
Interworking with Underlying Network(s)

- oneM2M can run on top of plain IP network
- However, **Mcn interface** to **NSE** enables fine-grained control
- Focus in particular: **3GPP networks**

3GPP cellular network as universal transport for M2M applications
- Wireless reachability
- Globally deployed
- Cellular operators may also deploy M2M platform
- May avoid necessity of M2M local network (modem cost < 5$, SoC)

- 3GPP Service Capability Exposure Function (SCEF)
  - Configuring Communication Patterns, Session QoS, Session Sponsorship
  - Background Data Transfer
  - Monitoring
  - Device Triggering
  - Group Messaging (via MBMS)



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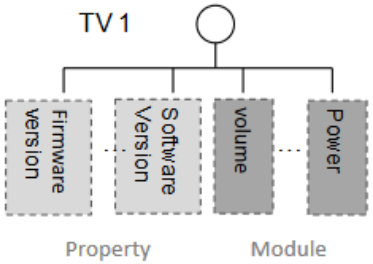
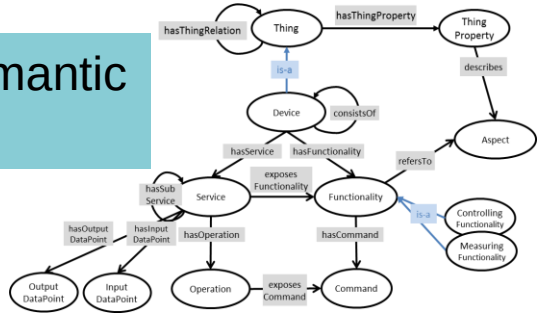
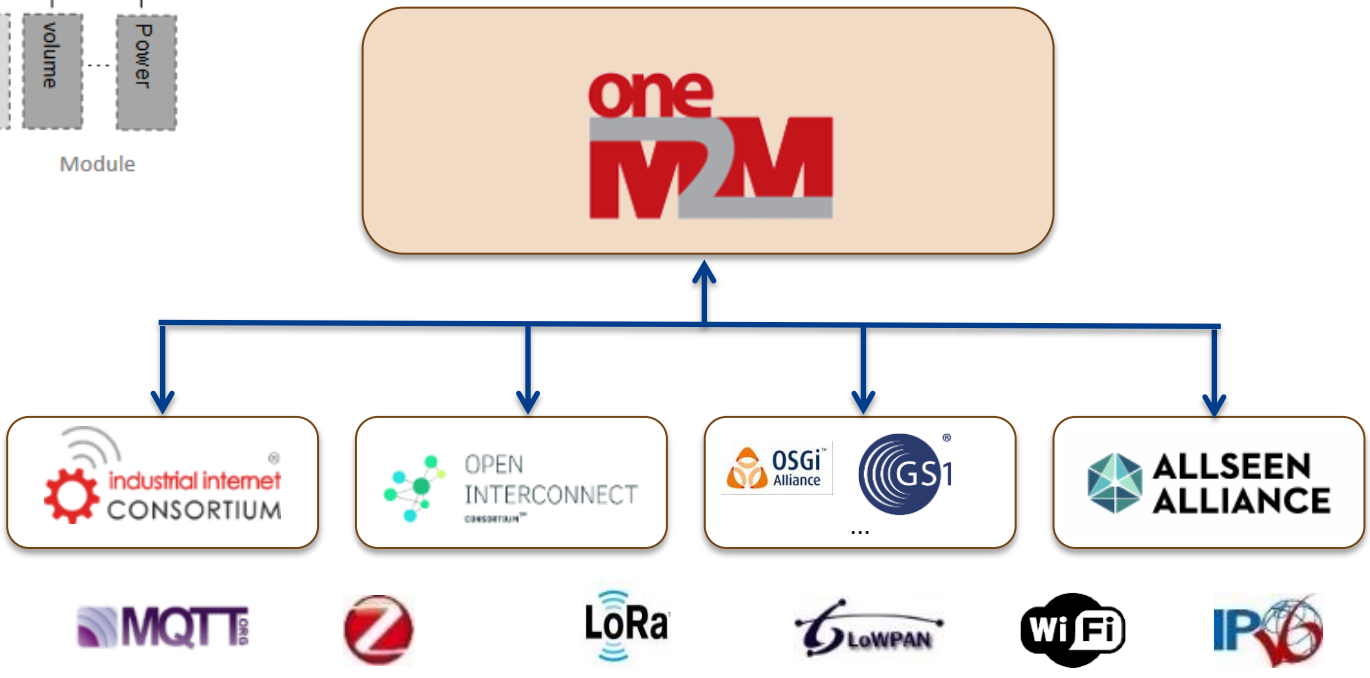
oneM2M Interworking

Specific Abstraction Models, e.g. Home Automation



General Semantic Approach





Platforms

Technologies

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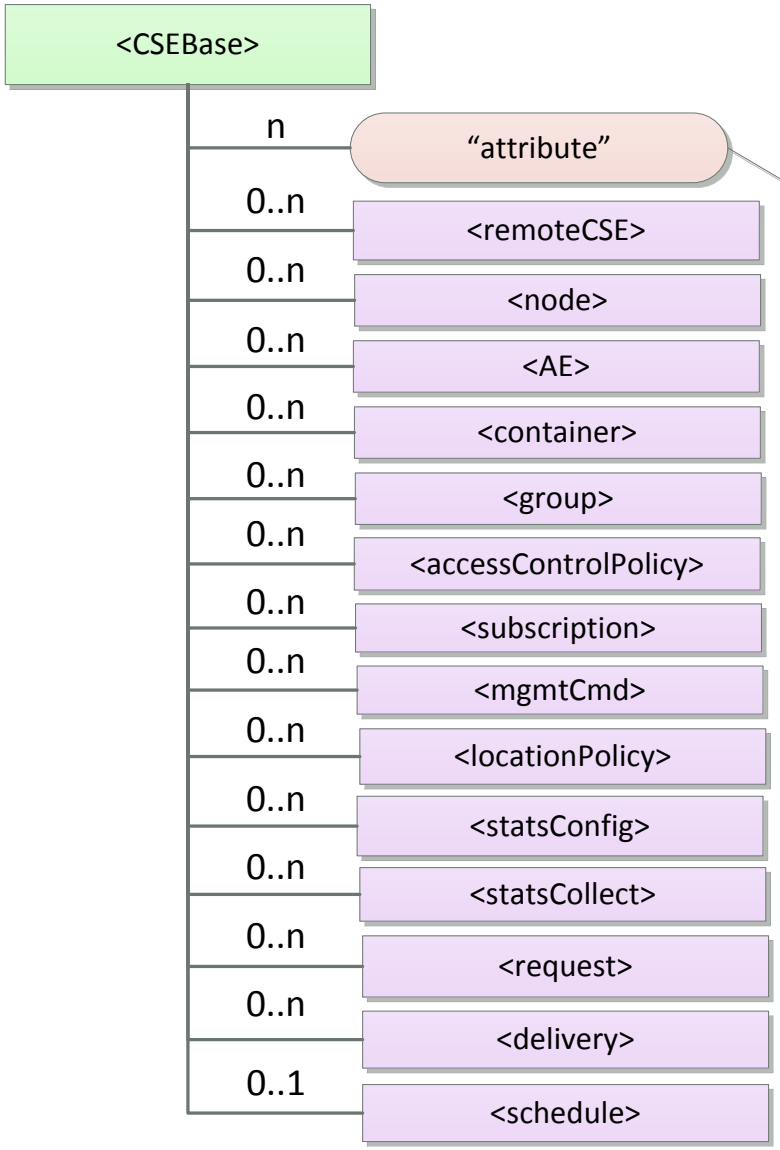
oneM2M REST Resource Structure



Common Attributes:

- resourceType
- resourceID
- parentID
- expirationTime
- accessControlPolicyIDs
- labels
- creationTime
- lastModifiedTime
- stateTag
- announceTo
- announcedAttribute

CSEBase Specific Attributes:

- cseType
- pointOfAccess
- CSEBase
- CSE-ID
- M2M-Ext-ID
- TriggerRicipient-ID
- requestReachability
- nodeLink

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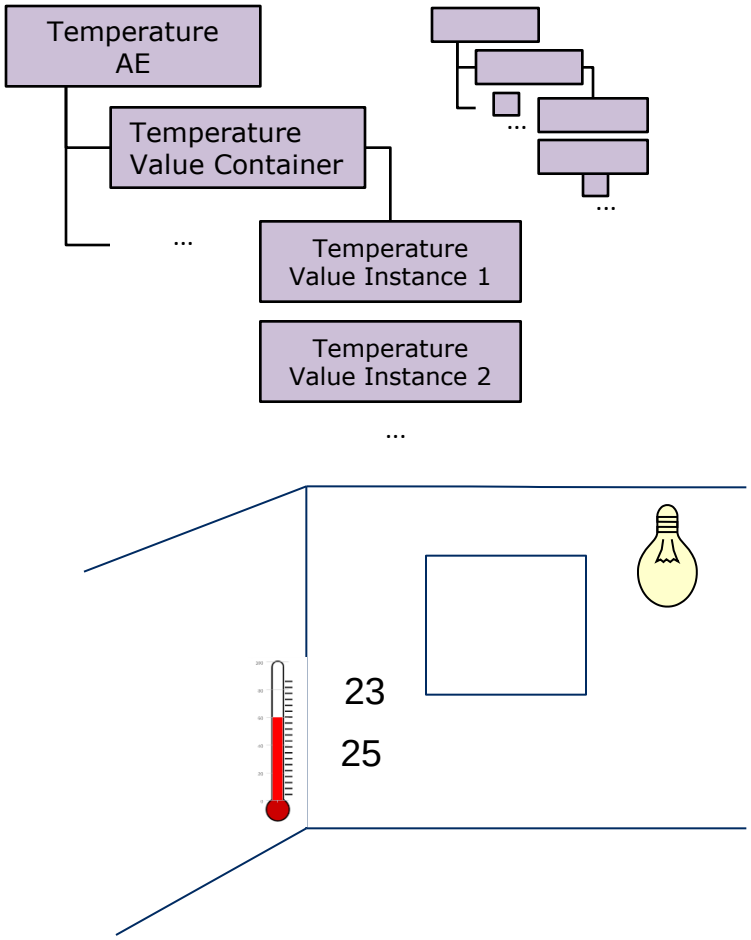
Example: oneM2M Release 1 – without Semantics

Building Management Application



- oneM2M provides resource structure for sensor applications to provide their information
- Syntax and semantics of information not visible to the platform
  - At best limited support for discovery (explicit tags)
  - No support for efficient access to structured information, creation of mash-ups, support for analytics
- Applications using the information have to a-priori know
  - Resources provided by each sensor applications
  - Syntax and semantics of information
- Explicit configuration step for every change in available sensors

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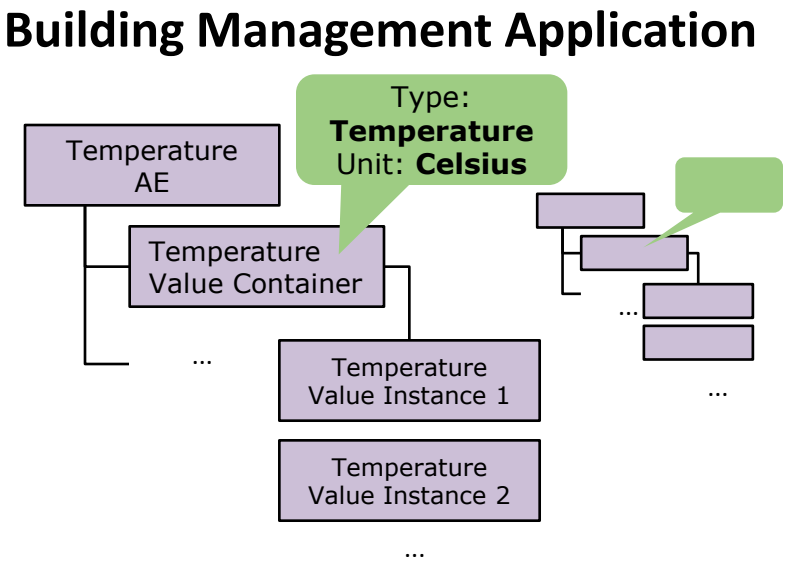
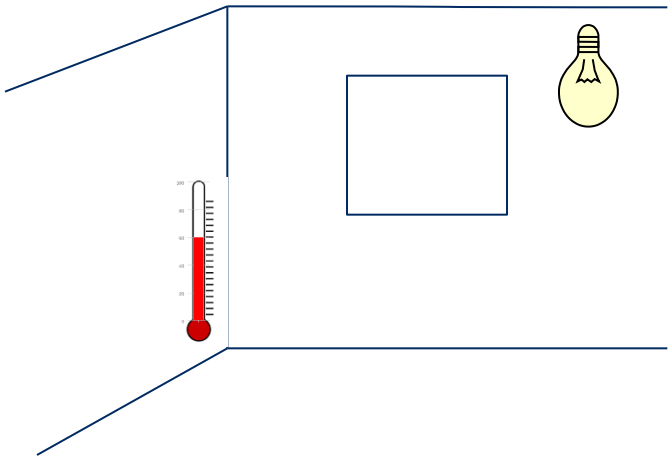
Example: oneM2M Release ≥2 – with Semantics





- oneM2M provides resource structure for sensor applications to provide their information
- oneM2M provides semantic information about resource contents and functionalities making use of it
- Functionalities that can be provided or enhanced using semantics
  - Queries/Discovery based on semantic descriptions
  - *Support for analytics*
  - *Support for creation of mash-ups (e.g. enabling IoT scenarios)*
- Applications using the information can
  - Specify what information they are interested in → be notified in case of relevant changes
  - Syntax and semantics of information is made explicit, so applications can decide whether they can handle it, what module is needed for processing etc.

Automatic configuration for every change in available sensors

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oneM2M as Horizontal Integration and Homogenization Layer

- Common IoT Service Layer
- Controls and utilizes underlying network
- Enables distributed deployment
- Enables cross-domain interoperability
- Provides support for interworking
- Enables contextualization using semantics

- No common information model
- Discovery of resources, not content information directly

→ Applications have to request a lot of (ultimately unnecessary) information and filter themselves

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FIWARE

IoT Abstraction and Aggregation

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FIWARE Birth

- 2010 the European Commission triggers discussions on creating a „**FUTURE Internet PPP**"
  (PPP = Public-Private Partnership: the EC on the public side and a group of industrial organisations forming an association on the private side)
- Goal: Development and adoption of Future Internet technologies by Industry, SMEs and Entrepreneur
- Investment of **600M€** in total, 158 Organisations from 23 countries, 37 projects
- Only limited research, main target is **innovation** in an operational pan-European platform

Branding**: initially „**FI-WARE**" was the core platform project in the first phase. This name became so prominent that it was adopted as branding name for the complete activity, ecosystem and results: **FIWARE

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FI-PPP Approach

- Taking the **leading ICT companies** in Europe together and develop a joint FI platform.
- Define **modularized architecture** for a FI core platform based on **existing standards** and modularized in so-called „Core Enablers"
- Provide **powerful set of APIs** to the architecture components
- Create an **open source reference implementation**
- Put a **large number of use case projects** (accelerators), mainly with Small-and-Medium-Sized-companies (SMEs), research and higher education organisations on top of the platform to develop market ready solutions.

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From EU Project to private Foundation

- Last projects ended by 31 Dec 2016
- 27. Sep 2016: incubation of the FIWARE Foundation
- FIWARE Foundation (FF) takes over the maintenance, administration, exploitation and marketing of the FIWARE Ecosystem – it takes over FIWARE
- FF will be the instance which has the full control over policies and future roadmaps
- Different membership models possible: pure contributing ones (FIWARE Open Source Community) or influential ones.
- NEC Corporation is a Platinum Member of the FIWARE Foundation

More information on www.fiware.org

FIWARE FOUNDATION

Moving Forward
Going Global

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FIWARE Chapters

Cloud

- Federation of infrastructures (private/public regions)
- Automated GE deployment

Data/Media Context Mgmt

- Complete Context Management Platform
- Integration of Data and Media Content

IoT Services Enablement

- Easy plug&play of devices using multiple protocols
- Automated Measurements/Action ←→Context updates

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Data/Services Delivery

- Visualization of data (operation dashboards)
- Publication of data sets/services

Advanced Web UI

- Easy incorporation of advanced 3D and AR features
- Visual representation of context information

Security

- Security Monitoring
- Built-in Identity/Access/Privacy Management

I2ND

- Advanced networking (SDN) and middleware
- Interface to robots

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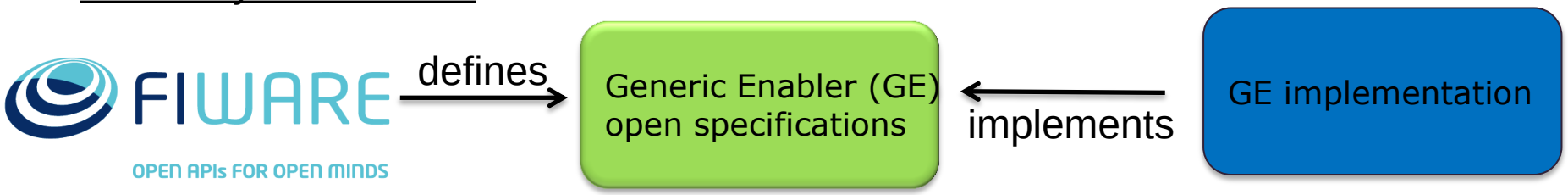
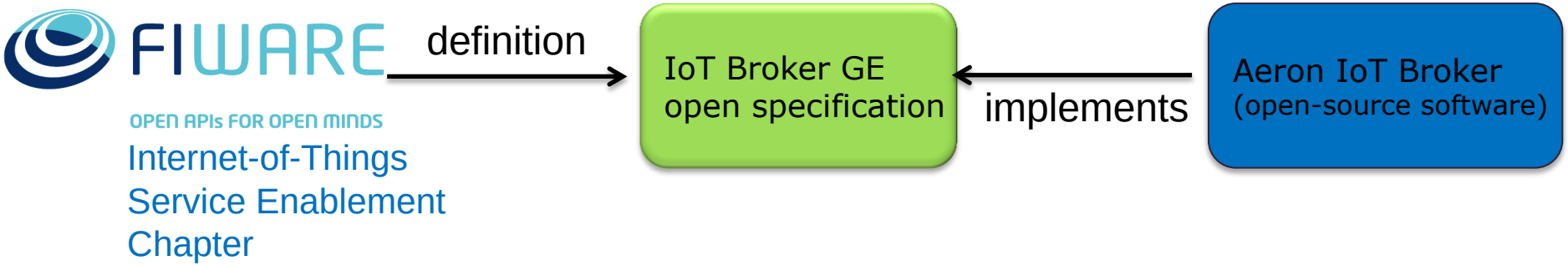
FIWARE Platform

- Modular Platform consisting of GEs
- GEs use standard APIs where possible

Generally in FIWARE:



In case of the IoT Broker:



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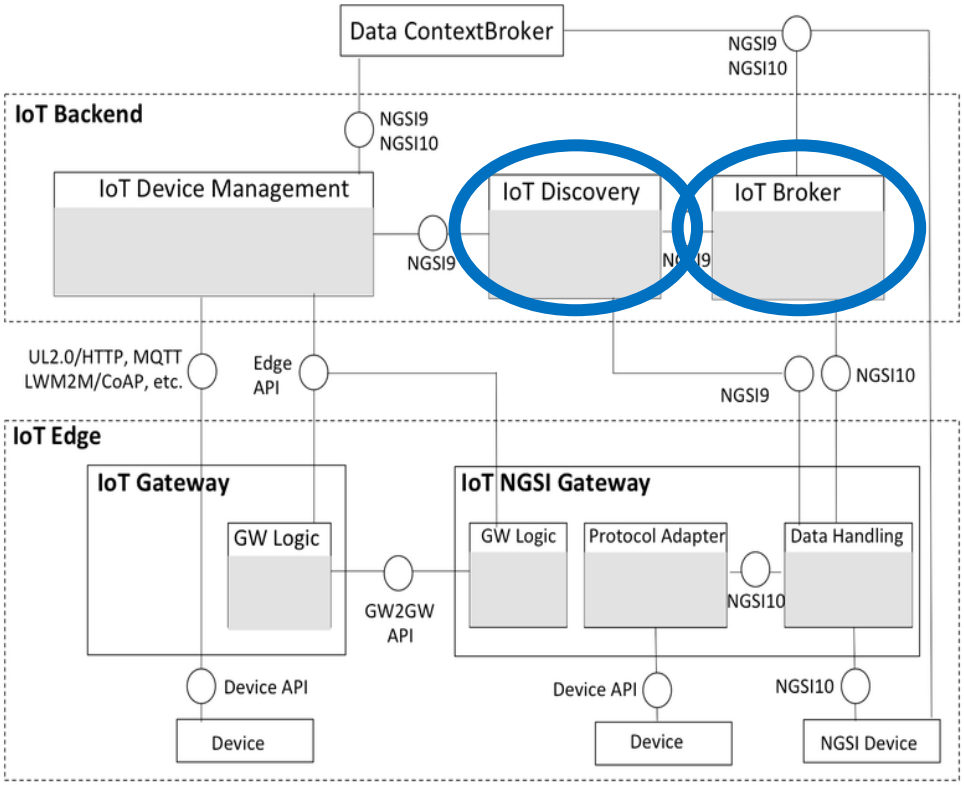
FIWARE Internet-of-Things Chapter

- Provides enablers targeting Internet-of-Things applications
- IoT domain is divided between IoT Gateway/Edge and IoT Backend
- FIWARE NGSI plays central role as main API

NEC Enablers



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Core NGSI Context Interface Concepts (1)

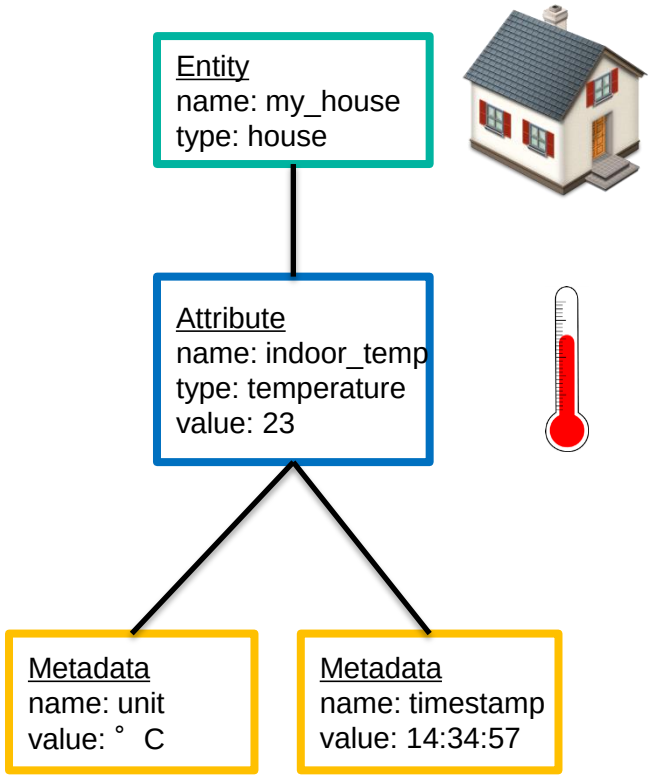
Next Generation Service Interfaces defined by OMA Includes Context Interfaces

Goal

- Allow applications to **specify and request the context information they need**
- Enable **efficient access** to this information (also in a highly **distributed system**)

Information Modelling

- **Entities**, e.g. physical objects like *buildings*, *cars*, *tables* etc. but also more abstract things like *coverage area of wireless network*
- **Attributes** describe aspects of entities, e.g. indoor temperature (of a room)
- Attributes have a **name**, **type**, **value** and **meta information**



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Core NGSI Context Interface Concepts (2)

Goal

- Allow applications to **specify and request the context information they need**
- Enable **efficient access** to this information (also in a highly **distributed system**)

Requests

- Request entity information based on (**entity id | entity id pattern / entity type**) and **attribute(s)**
- Support **one-time synchronous access** (**query**) and **continuous asynchronous access** (**subscription/notification**)
- Support **update** operation (to create, update or delete information)

Subscription:
notify if *my_house*, *indoor_temp* <15 C

Query:
type *car*
scope: <geo_area>
return: car id, speed

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Aeron: The NEC IoT Broker

Technical Advantages

Application Layer

Smart Home App | Smart City App | Smart Agriculture App

IoT Broker Layer

Role of Aeron: *Make the IoT do what the applications need.*

Data
- Entity Model
- Semantic Discovery

Processing
- World-wide Operation
- Federation
- Edge Processing

Meaning
- IoT Analytics
- Contextualization
- Sem. Mediation

IoT Device Layer

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FIWARE as IoT Abstraction and Aggregation Layer

- Common abstract information model (entity-attribute model)
- Efficient discovery and access to content information
- Fine-grained filtering of information
- Enables federation across domains

- Limited support for interworking with other technologies and platforms
- No device-related functionality, e.g. device management
- No communication control functionality

→ More integration work required and little communication control

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How Do Standards Fit Together?

oneM2M

+ Provides common IoT Service Layer
+ Controls and utilizes underlying network
+ Provides support for interworking
+ Enables contextualization using semantics
- No common information model
- Discovery of resources, not content information directly

→ Applications have to request a lot of information and filter themselves

FIWARE

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Complementary strengths and weaknesses

Combine? How?

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IoT and Smart Cities

Research and Innovation

Research and Innovation

Best of oneM2M and FIWARE

→**Wise-IoT Project**

- High-level Architecture
- Semantic Mediation Gateway

Evolution: Elastic IoT

- Orchestration
- Edge Analytics

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EU H2020 - Korea Project: WISE-IoT

Worldwide Interoperability for Semantic IoT

Trust Privacy and security

- Application and service portability in complex scenarios
- Smart objects and semantic interoperability
- Standards Interoperability & Interworking
- Common IoT reference architecture

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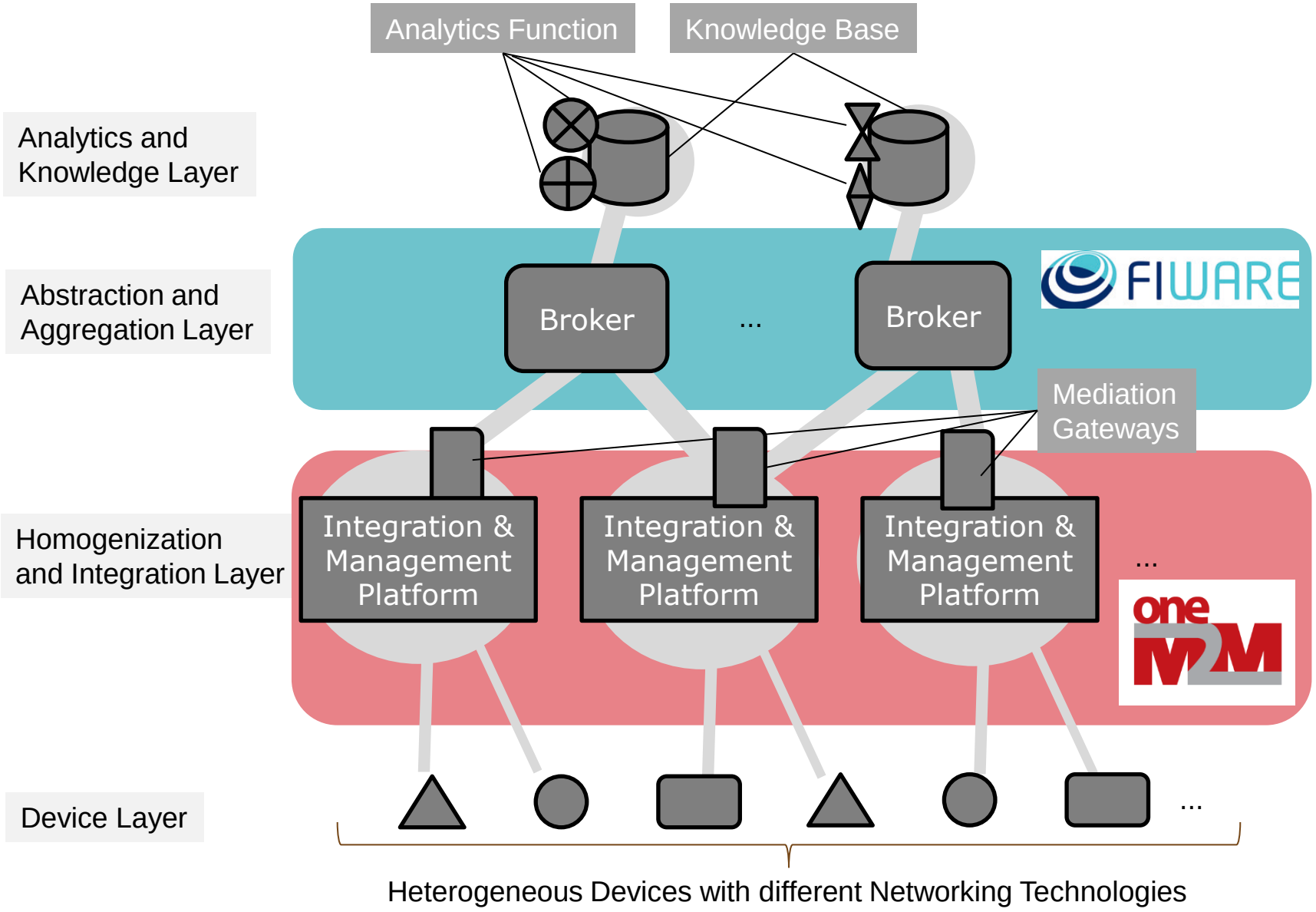
Wise-IoT has received EU H2020 funding under grant agreement No 723156

High-level Architecture



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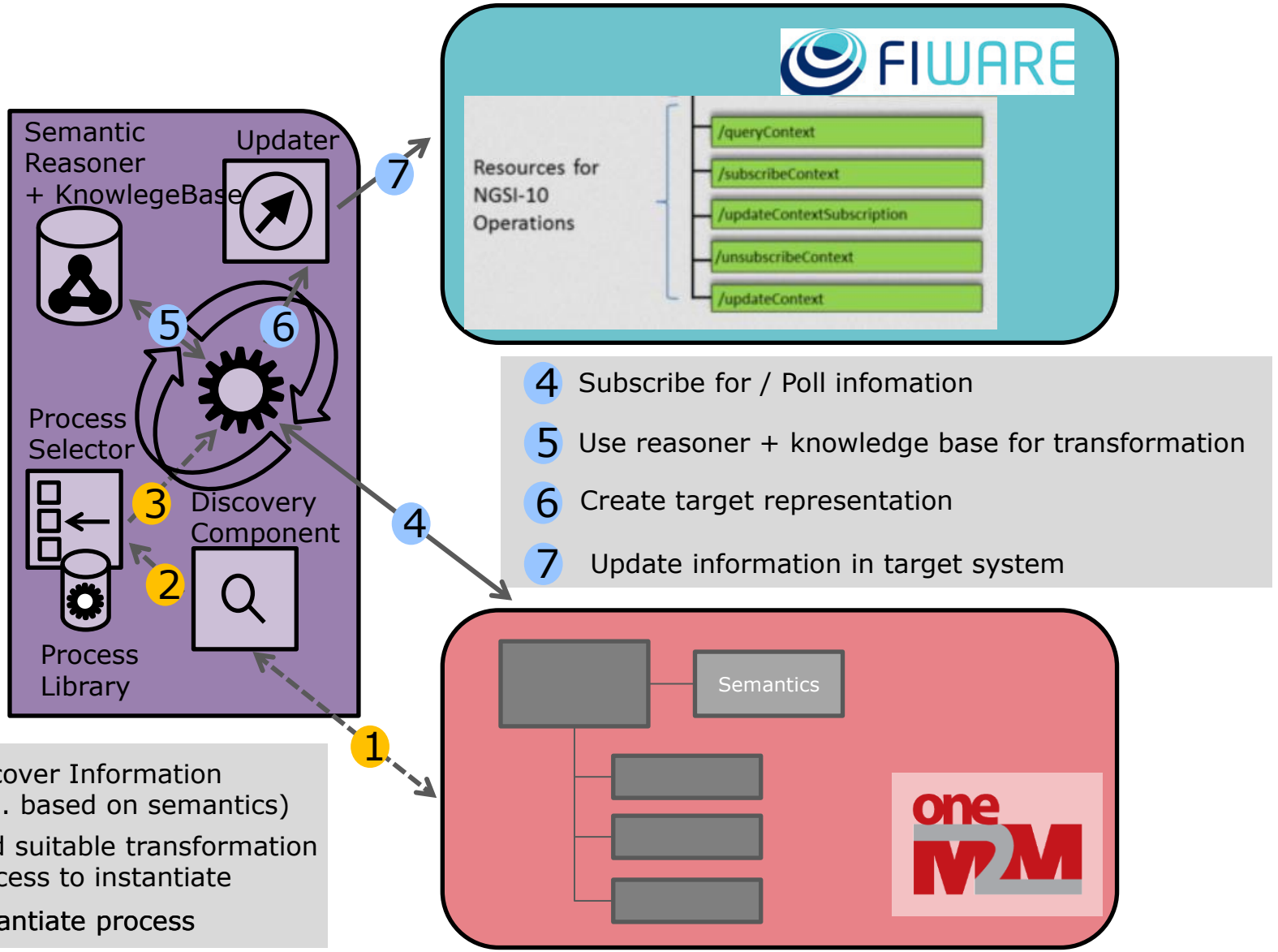
Mediation Gateway



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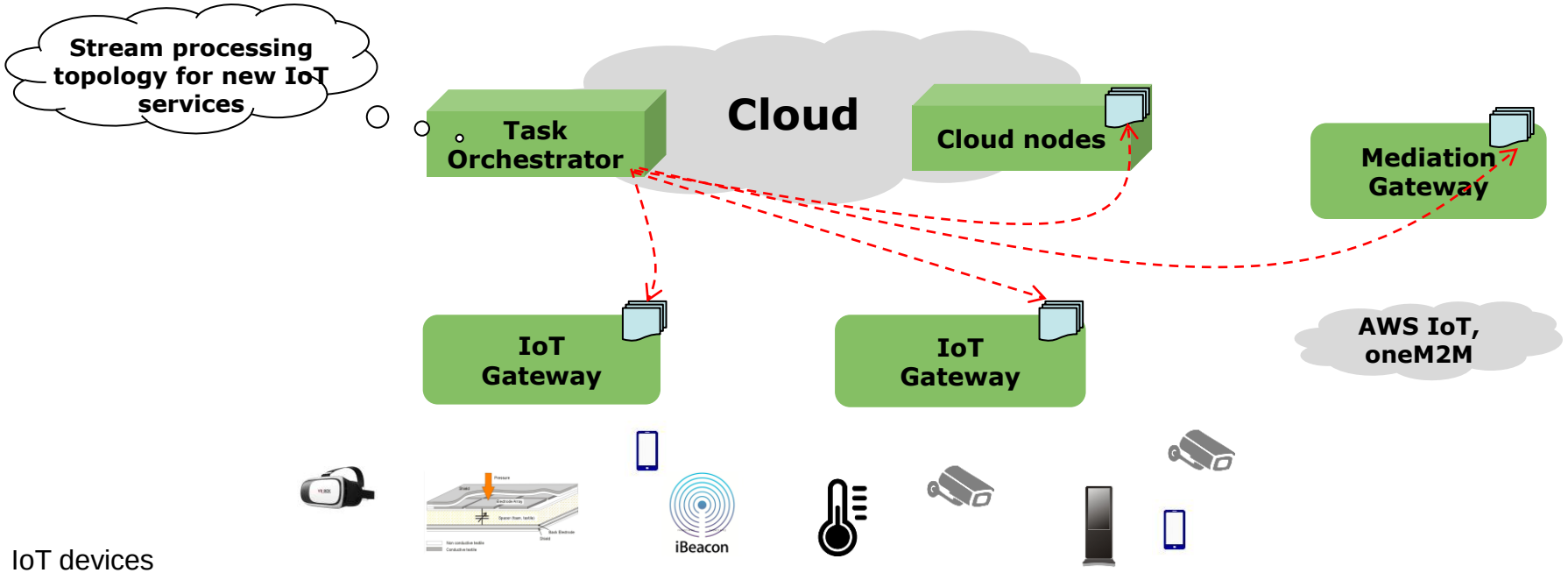
Elastic IoT: IoT Platform with Edge Analytics

Elastic IoT: IoT data analytics functions can be elastically and automatically assigned to clouds and/or edge nodes to enable time critical and cost-efficient IoT services

- Flexible programming model and FIWARE NGSI based interfaces: easy integration & fast time to market, standard-based (avoid vendor lock-in)
- Sophisticated task orchestration cross the Cloud and Edges (mobility aware and proximity aware, optimizing bandwidth consumption and latency)
- Mediation Gateway: semantic interoperability with other IoT systems (oneM2M, AWS IoT)



IoT devices
(printed sensors, camera, glasses for VR, mobile devices)

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Orchestrating a brighter world

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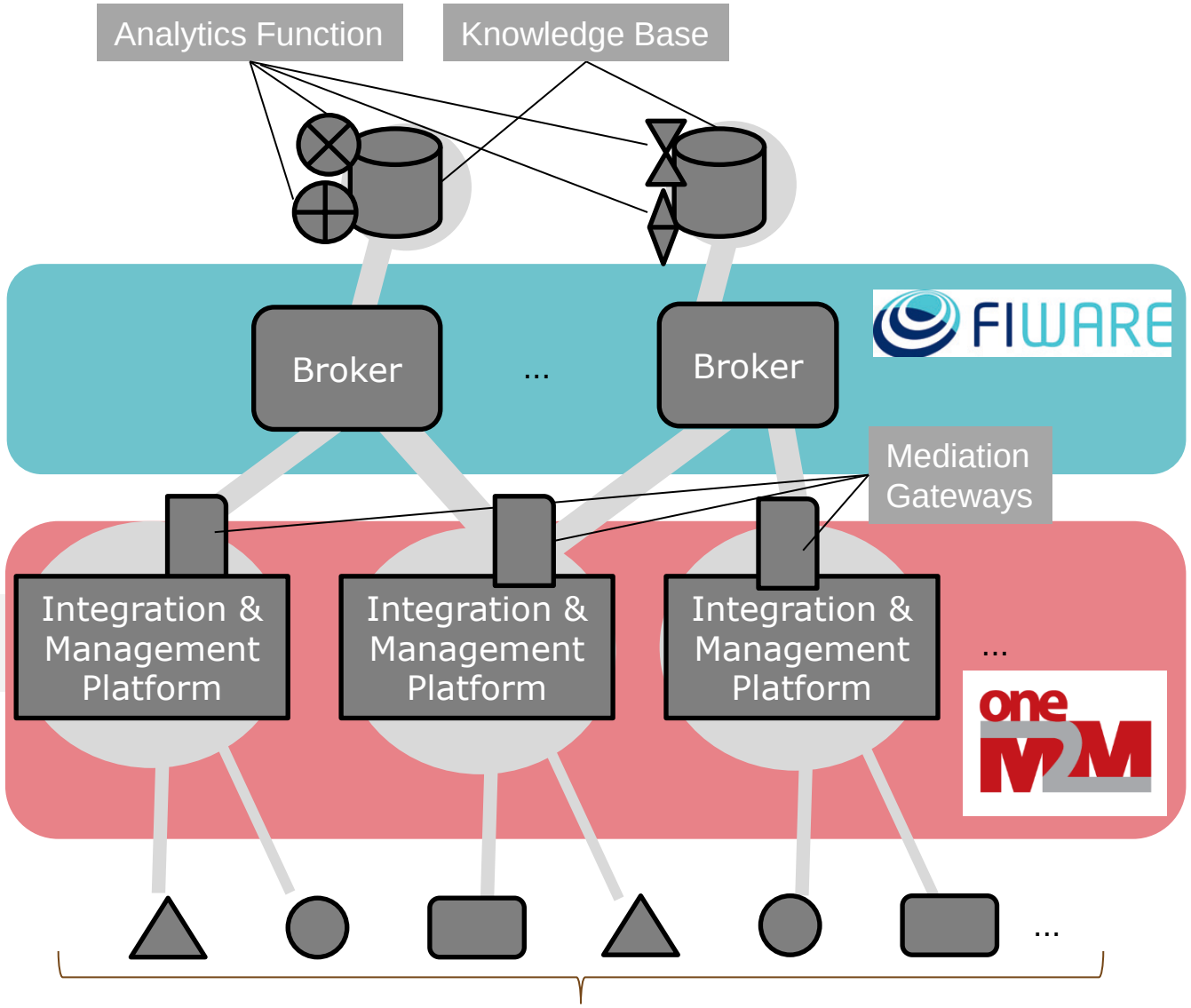
IoT and Smart Cities

Outlook

Summary



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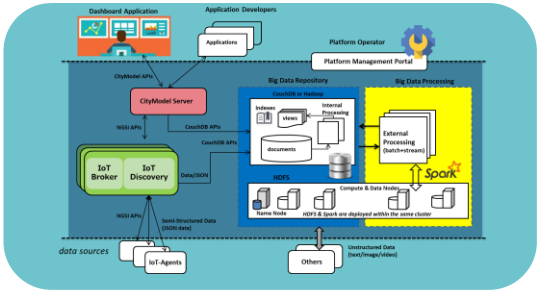
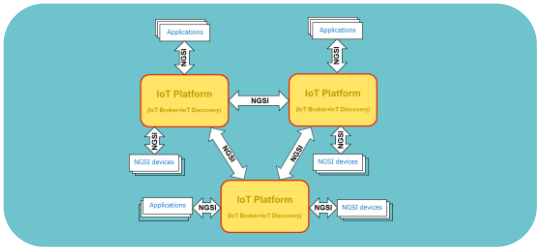
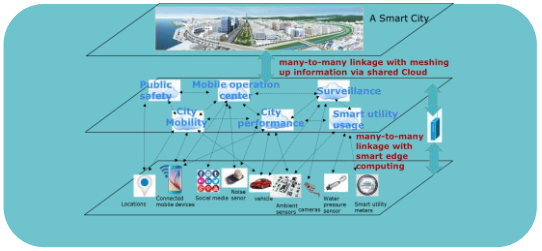
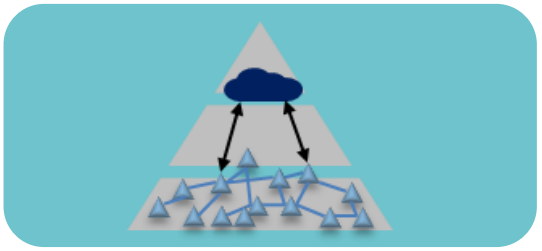
Outlook: Future Technology Trends









IoT Clouds [today state-of-the-art]

Today

- Cloud-based provisioning of IoT services
- NEC product: Cloud City Operation Center

Elastic IoT [emerging]

1-3 year

- From central cloud to federation & brokering: Cloud-of-Cloud, System-of-System
- Edge Computing & automated functional distribution, devops
- IoT network re-configuration

Hyperconnected IoT [Next Gen Discussion]

3-5 year

- Business mode: many-to-many data sharing
- semantic interoperability, multi-source data analysis, semantic context, sharing of control
- massive orchestration

Extreme IoT [R&D starting]

5-10 year

- Massive use: „100-10K IoT objects **per room**“
- IoT & 5G: IoT into every (!) object
  → network impact , advance discovery & contextualized orchestration, tactile control

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Erno Kovacs; Martin Bauer; Jaeho Kim; Jaeseok Yun; Franck Le Gall; Mengxuan Zhao, **Standards-Based Worldwide Semantic Interoperability for IoT**, IEEE Communications Magazine, Volume: 54, Issue: 12, December 2016, pp. 40 - 46, DOI: 10.1109/MCOM.2016.1600460CM

Orchestrating a brighter world

NEC brings together and integrates technology and expertise to create the ICT-enabled society of tomorrow.
We collaborate closely with partners and customers around the world, orchestrating each project to ensure all its parts are fine-tuned to local needs.

Every day, our innovative solutions for society contribute to greater safety, security, efficiency and equality, and enable people to live brighter lives.